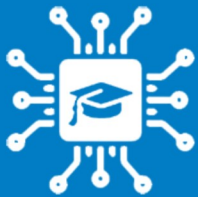# Microelectronics education for a sustainable tomorrow: A perspective from the GreenChips-EDU project

by GreenChips-EDU

In recent decades, the microelectronics industry has profoundly transformed our world. Since Jack S. Kilby invented the microchip almost sixty years ago, this industry has experienced remarkable growth and innovation. Today, integrated circuits (ICs) containing billions of transistors are integral to nearly every electronic system, from automotive and industrial applications to consumer electronics, avionics, and space technologies. ICs drive technological advancements in areas such as smartphones, security systems, automated driving, smart manufacturing, and the Internet of Things. These components are crucial for shaping our future, providing the foundation for modern applications, and enhancing Europe's competitiveness and innovation.

To reinforce European leadership in semiconductor technologies and applications, the European Chips Act was enacted on September 21, 2023. This comprehensive set of measures aims to secure the EU's supply chain, enhance resilience, and establish technological leadership by boosting manufacturing within the EU, supporting the European design ecosystem, and fostering growth and innovation across the entire value chain. The European Commission's goal is to increase the EU's global market share in this sector to 20 percent by 2030.

Elevating the European microelectronics industry and supporting the operation of new semiconductor production facilities require a substantial number of skilled engineers and technicians. To address the current shortage of skilled workers, seven European universities have partnered with eight industry and research organisations in the EU-funded "GreenChips-EDU" project. Six of these universities are part of "Unite!", a strategic alliance of European technical universities. GreenChips-EDU aims to develop a joint European education program in electrical engineering and microelectronics to effectively train future specialists. Additionally, the project will establish higher education programs for industry professionals, offering a range of options from short, self-standing modules and microcredentials to MBA programs. To attract more young people to the field of microelectronics, the project emphasises digital content and interactive teaching formats, promoting a more sustainable development of microchips. Through these initiatives, the project aims to increase the number of individuals pursuing careers in the semiconductor industry.

Vision and concepts towards new degrees

The development of new degree programs will build upon the existing master's programs offered by the participating universities. These typically four-semester programs introduce students to essential

foundational courses at the beginning. As part of the project, these foundational courses will be converted to online formats whenever possible. As students advance in their studies, they will select from a variety of courses focusing on chips and applications, with an emphasis on sustainable production. To complete the degree, students must write a thesis on a "green electronics" topic. Additionally, they will be encouraged to participate in summer schools, hackathons, or makerspaces as part of the program.

Upon graduation, students will receive a master's degree and, depending on their university program, may also earn an additional certificate or a specialisation in "green electronics". Since six universities participate in the Unite! program, students will have the opportunity to enrol in and complete a double degree program during the project. The establishment of double-degree programs is envisioned to further bolster student mobility and cross-cultural academic experiences.

Building on existing master's programs allows the first student pilot cohort to begin as early as the second year of the project, facilitating the testing and fine-tuning of the approach.

Additionally, the GreenChips-EDU project plans to establish lifelong learning modules and an MBA for professionals working in the semiconductor industry. The first step is to organise a workshop with partners to identify the needs related to sustainability and energy efficiency in the industry. The partners aim at defining the skills and knowledge that could be provided by the project to fill this gap through tailored courses and an MBA. Most partner universities have established "Life Long Learning" departments that can efficiently handle roles in upskilling and reskilling. In addition to the highly modularized 5 ECTS modules offered in their master's programs, the plan includes offering shorter, digitally enhanced learning materials (microcredentials) to enhance knowledge in specific areas for both students and experienced professionals.

Content development strategies

A significant challenge will be adapting and implementing the content within a common platform, as most of the existing courses were already created and stored in the Learning Management Systems (LMS) of the partner universities. As a first step, the GreenChips-EDU consortium decided to use Unite!'s platform, Metacampus, to transfer courses and learning materials, enabling easy access for all Unite! students. In some cases, due to the difficulty of migrating all the content from one local platform to another, links will be provided in Metacampus to redirect students to the local LMS.

Since some of the content is based on on-site courses, it is planned to offer the possibility to follow some of the courses in hybrid mode (remote and on-site at the same time). This involves setting up the classroom and training the lecturers to effectively deliver their courses in digital format. These courses will be recorded and combined with the slide presentations to create digital versions. By using authoring tools such as Articulate Rise and Storyline, it is intended to create interactions, activities and assessments as a way to engage the students as they view the course. All types of scientific and academic events organised by partner universities related to sustainable electronics, such as seminars and workshops, are suitable for live streaming and recording for future reuse. In other cases, the goal is to create self-paced modules based on the existing content, so that students could complete the course on their own at any time. These courses were designed from zero by using the former tools that allow integrating interactive content based on multimedia elements (videos, images, animations, etc.). The advantage of these tools is that they offer the possibility to export content in SCORM format, which can be easily imported into any LMS.

Fostering mobility and industry engagement

One of the key objectives of the project is to attract skilled staff and support students to fulfil the goals of the European Chips Act. This involves implementing various activities such as staff exchanges, student mobility programs and scholarships. In addition to the existing programs such as Erasmus and the Unite! Partnership, the project aims to organise internships, Summer Schools, Learn-Repair-Cafés and Hackathons at diverse locations across Europe, with a special focus on Sustainable Electronics. The idea stems from the growing environmental awareness of students and the fact that the number of courses on Sustainable Electronics offered by engineering schools is still very limited. These interactive formats also provide an opportunity to introduce students to the realities of the industry, by working directly with industry partners. These multifaceted initiatives underscore the project's commitment to nurturing a diverse, inclusive, and globally connected educational ecosystem within the microelectronics field. The involvement of industry partners is essential in bridging the gap between academia and the semiconductor industry. By sharing state-of-the-art technologies, innovative processes, insights and market trends, industry experts can enrich the learning experience for students and contribute to the development of future skilled workforce.